

## SCIENCE NEED STATEMENT

### Remediation--Reactivity of Organics in the Hanford Subsurface

**Identification No.:** RL-SS32-S

**Date:** September 2001

**Program:** Environmental Restoration

**OPS Office/Site:** Richland Operations Office/Hanford Site

**Operable Unit(s):** Broad need potentially applicable to multiple operable units.

**PBS No.:** RL-SS04 (RL-VZ01)

**Waste Stream:** Groundwater (Disposition Map Designation: ER-10 [technical risk score 5] and ER-18 [technical risk score 5]), Soil (Disposition Map Designations: ER-04 [technical risk score 3], ER-14 [technical risk score 5], ER-03 [technical risk score 3])

**TSD Title:**

**Operable Unit (if applicable):** N/A

**Waste Management Unit (if applicable):** N/A

**Facility:** N/A

#### Priority Rating:

This entry addresses the "Accelerated Cleanup: Paths to Closure (ACPC)" Priority: Select a "1", "2" or "3" to assess the impact of the need/opportunity relative to the current site baseline.

- ☒ 1. Critical to the success of the ACPC
- ☐ 2. Provides substantial benefit to ACPC projects (e.g., moderate to high lifecycle cost savings or risk reduction, increased likelihood of compliance, increased assurance to avoid schedule delays)
- ☐ 3. Provides opportunities for significant, but lower cost savings or risk reduction, and may reduce uncertainty in ACPC project success.

**Need Title:** Remediation--Reactivity of Organics in the Hanford Subsurface

**Need/Opportunity Category:** Science Need

**Need Description:** For naturally occurring organic matter and synthetic organic compounds in the Hanford subsurface, determine the rates of degradation reactions that supply energy to subsurface biological consortia that participate in dechlorination of halogenated solvents.

The biodegradation of halogenated organic compounds (TCE, PCE, DCE, TCA, DCA--CCl<sub>4</sub>, PCBs--primarily anaerobic) and metal/radionuclide organic complexes (EDTA, ED3A, citrate--aerobic or anaerobic) requires knowledge of the biochemical mechanisms/enzymes involved in the transformations. Potentially, the halogenated organic compounds undergo reductive dehalogenation by anaerobic bacteria. It will be important to determine the molecular phylogeny of these organisms and how they interact physiologically to degrade halogenated organics. The kinetics of the individual reactions must be known to determine whether pathways/enzymes can

be engineered to overcome kinetic limitations. Science needs also include determining the electron donors that drive microbial dehalogenation and the stoichiometries required for complete dehalogenation of chlorinated organic compounds. For biodegradation of chelating agents, it will be important to know the speciation of contaminants with these agents, the metabolic pathways and enzymes involved, and the molecular basis for the substrate selectivity exhibited by transport and catabolic enzymes. Likewise, it will be important to determine the fate of the radionuclide or metal after the organic moiety has been degraded.

Scientific issues associated with the nature of in-situ microbial consortia and their potential role in the transformation of contaminants include knowing the endogenous rates of microbial metabolism and how they relate to contaminant attenuation. It will be important to determine the spatial distributions of microorganisms, the composition of the microbial community and its nutrient requirements, and the in-situ microbial degradative capabilities in order to understand the scale, range, and distribution of kinetic rates for contaminant degradation. Science will be required to address whether the chemical composition of the aqueous phase could be manipulated to facilitate the desired reactions in situ.

***Schedule Requirements:***

Earliest Date Required: 8/1/99

Latest Date Required: 9/30/15

***Problem Description:*** Natural organic matter constitutes a fraction of the minerals in most subsurface hydrogeologic environments. Synthetic organic compounds, such as organic acids or chelating agents, and chlorinated solvents, also occur in contaminated parts of the subsurface. These compounds can undergo biodegradation by subsurface microbial communities. The biodegradation of the different compounds occurs at varying rates, and in the case of certain chlorinated hydrocarbons, involves cometabolic processes. The reactivity of these organics depends on the chemistry of the groundwater system (oxic, anoxic) and the nature of the subsurface microbial consortia and its degradative abilities.

***Benefit to the Project Baseline of Filling Need:*** If the science needs are filled, then alternative technologies may be developed and deployed to enhance the rate of remediation of different organic compounds in the subsurface. Use of in-situ remedial technology rather than ex-situ treatment will reduce risk and provide cost savings

Benefit code: check all that apply:

- ✓ Cost Savings
- ✓ Risk Reduction
- ✓ Enabling Knowledge (i.e., solves a problem that cannot be remediated by current science/technology)

This Science Need also supports the following Hanford Subsurface Contaminant Technology Needs:

RL-SS34

Provide means to quantify the flux of contaminant between the groundwater and the Columbia River.

***Relevant PBS Milestone:*** PBS-MC-042

***End-User:*** Richland Environmental Restoration Project

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